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ABSTRACT

The goals of the Elementary and Secondary Education Act Title I program operated by the Public Schools of the District of Columbia were to provide disadvantaged children with supplemental instructional services to improve their performance in reading and mathematics and to support their affective and psychomotor development. This volume of the four-part evaluation focuses on the effectiveness of the instructional services provided to 15,000 students in grades K-7 during the 1978-79 school year. Instruction was provided in the classroom, in a laboratory setting, and/or in tutorials. For the evaluation, reading and mathematics achievement data were analyzed for grades 1, 2, 3, 4, and 7. Findings indicated that all grade levels exceeded program objectives for achievement gains, except grade 7. An appendix to the report explains the process of converting grade equivalent scores to Normal Curve Equivalents. (MK)

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EVALUATION OF THE ESEA TITLE I PROGRAM
OF THE PUBLIC SCHOOLS OF THE DISTRICT OF COLUMBIA

FINAL MODEL A REPORT

Evaluation of Program Impact on Reading and Mathematics Achievement

1978-79

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Prepared by: **NTS Research Corporation**

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Prepared by Becky Jon Hayward, Ph.D.
NTS Research Corporation

OCT 2 0 1980

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Becky Jon Hayward, Ph.D.

May 1980

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INTRODUCTION

An evaluation of the 1978-79 ESEA Title I Program operated in the Public Schools of the District of Columbia was conducted by NTS Research Corporation under contract to the Division of Research and Evaluation, District of Columbia Public Schools. The results of this evaluation are presented in a series of reports.[1] This report, Evaluation of Program Impact on Reading and Mathematics Achievement, fulfills the basic evaluation requirement specified by the United States Office of Education (USOE). The USOE-approved evaluation model selected as most appropriate for evaluation of the D.C. Title I report was the Model A design. Subsequent sections of this report include a brief overview of the Title I program, a description of the evaluation design and instrumentation, a presentation of the results, and a discussion of the implications of those results.

Overview of the Title I Program

The central goal of the ESEA Title I Program operated by the Public Schools of the District of Columbia is to provide disadvantaged children with supplementary instructional services which will enable them to improve their performance in reading and mathematics. Additionally, student affective and psychomotor development is emphasized as an important program goal. For academic year 1978-79, the program had a budget of approximately $14.6 million to provide

[1] Other reports in the series are Evaluation of the Title I Instructional Process and Support Components, Evaluation of the Impact of Title I Students' Background and Behavior on Educational and Affective Development, and Executive Summary.

supplementary instructional and support services to almost 15,000 Title I eligible students in 89 public and private elementary and junior high schools.[2] Students in grades kindergarten, one, two, three and seven were eligible to receive services. Additionally, a pilot fourth grade reading program was operated in selected schools.

Table 1 indicates the distribution by grade of students who received Title I services during the 1978-79 school year. As these data indicate, a total of almost 15,000 students received supplementary instruction in reading, mathematics, or reading and mathematics during the 1978-79 school year.

Table 1

Number of Students Receiving Title I Supplementary Instructional Services[a] by Grade (1978-79)
(Unduplicated)

Grade	Number of Students Served
K	2,845
1	3,172
2	2,697
3	3,147
4	902
7	2,091
Total	14,854

[a]For kindergarten, the number of students served included kindergarten students served by Title I aides and classroom teachers. For grades one, two, three, and seven, the number served is the total number of students who received laboratory instruction in reading or mathematics during the 1978-79 school year. Fourth graders received reading instruction only.

Source: Service data provided by Title I program office.

[2]A pilot program was planned for high schools but was not implemented in 1978-79. Appendix A includes a listing of Title I schools for 1978-79.

Program Selection Process

Selection of students for participation in the 1978-79 Title I program was based on two factors: residence in an eligible school attendance area and educational deprivation. School area eligibility was determined through use of a formula which weights the number of children from low-income families residing within the assigned school boundary as indicated by 1970 census data (40 percent) and the number of children eligible for free lunches in the year of selection (60 percent). Thus, eligible schools were determined on the basis of relative level of poverty in the area and on numbers of children affected by conditions of poverty.

For students residing in Title I school attendance areas, several factors were used to determine educational deprivation, including:

- scores at or below the fortieth percentile on the reading or mathematics section of the Comprehensive Tests of Basic Skills (CTBS) administered in the previous spring;
- over age for grade; and
- repeat of a grade.[3]

Additionally, students could be recommended for Title I services by their teachers or principals if they had transferred into the school attendance area and for this or some other reason did not have achievement test scores, or if their classroom performance was substantially lower than their test scores predicted. In such cases, documentation was required to support the selection.

Program Objectives and Expected Outcomes

Objectives. As indicated previously, the major goal of the 1978-79 program was to improve the academic, psychomotor, and effective performance and behavior of Title I students. To facilitate achievement of this goal, a number of student-

[3]Students who have repeated or are over age for grade are eligible for Title I services regardless of their achievement test scores.

related objectives were delineated. Objectives in each of the four major areas of program focus (reading achievement, mathematics achievement, psychomotor skills, and affective behavior) included the following:

> Given eight months of Title I supplementary instruction services, identified Title I students in kindergarten through grade 3 and in grade 7 will achieve a mean gain of ten months in reading, as measured by standardized achievement tests.
>
> Given eight months of Title I supplementary instruction services, identified Title I students in kindergarten through grade 3 and in grade 7 will achieve a mean gain of ten months in mathematics, as measured by standardized achievement tests.
>
> Given eight months of Title I supplementary instruction services, identified Title I students in kindergarten through grade 3 and in grade 7 will demonstrate a positive change in affective behaviors, as reported by measures of affective growth.
>
> Given eight months of Title I supplementary instruction services, identified Title I students in kindergarten through grade 3 and in grade 7 will demonstrate growth in psychomotor development, as indicated by measures of psychomotor growth.[4]

Expected outcomes. For each of the program objectives focusing on academic performance, a set of expected student outcomes was articulated. For reading, these outcomes included the following:

- an increase in the quantity and quality of student verbal interaction, as measured by informal tests and adult-student observations;
- an increase in student listening comprehension skills, as indicated by measures of listening comprehension;
- an increase in student listening, speaking, reading, and writing vocabularies, as measured by informal and standardized measures and tests;
- an increase in student ability to attack new words, as measured by individual reading inventories;
- an increase in student reading comprehension, as measured by informal and standardized tests;
- an increase in the quality and quantity of books read by students, as measured by records maintained by teachers and students; and

[4]Source: ESEA Title I Comprehensive Program Description for FY 1979, Public Schools of the District of Columbia.

- an increase in the quantity and quality of student written language expression, as measured by a comparative record maintained by teachers and students.

Expected student outcomes in mathematics included:

- an increase in student understanding of the language of mathematics, as measured by informal and standardized tests;
- an increase in student understanding and verbalization of the concepts of mathematics, as measured by observation and informal standardized tests;
- an increase in student computational skills, as measured by informal and standardized tests;
- an increase in student problem-solving abilities, as measured by informal and standardized tests;
- an increase in student ability and opportunity to apply mathematical skills to practical life experiences, as indicated by adult-student observations; and
- an increase in student interest in and appreciation for mathematics, as measured by adult-student observations and attitude scales.

Finally, the program identified a series of affective outcomes which could be expected of students participating in the 1978-79 Title I program. These included:

- a positive self-concept, as indicated by measures of affective growth;
- a positive interest in and attitude toward the school curriculum, as indicated by measures of affective growth;
- positive peer relationships among students, as indicated by measures of affective growth; and
- positive relationships between students and adults, as indicated by measures of affective growth.

Program Services

Two major types of services were provided by the 1978-79 Title I program to facilitate achievement of program objectives and outcomes. The major service offered was supplementary instruction in reading and mathematics. Additionally, a number of support and optional services were available to Title I participants.

A brief description of these services is presented in this section.

Supplementary instructional services. At the elementary level (grades one, two, and three)[5], the Title I supplementary instructional program includes three components, or interventions: the laboratory program, the tutorial program, and the classroom program. For seventh graders, instructional services include the laboratory and tutorial programs.

The laboratory program provides participants with 45 minutes in elementary and 55 minutes in junior high school of reading or mathematics instruction daily in a laboratory setting for a full school year. In elementary schools, laboratories are staffed by a team consisting of a Title I teacher, educational aide, and program assistant. In general, Title I junior high schools have two teachers and two educational aides to provide laboratory instruction. In both elementary and junior high schools, the lab program is the major component of the Title I supplementary instructional services.

The second major component of Title I instructional services at both the elementary and junior high school levels is the tutorial program. This component provides additional reading or mathematics instruction to laboratory participants who have been recommended by their lab teacher and have parental permission to attend. The tutorial program operates either before or after school on Monday through Thursday and is staffed by educational aides.

The third component of Title I instructional services is the classroom program. This component provides special instruction in reading and mathematics to Title I students in kindergarten through grade three. Instruction is provided in the regular classroom by the regular classroom teacher for one and one-half hours per week. Additionally, Title I program assistants, parent-partners, and, in kindergarten, kindergarten aides serve as staff members for

[5]The Title I fourth grade program provided reading laboratory only.

the classroom component.

Support services. In addition to instructional services, a number of supportive services designed to facilitate achievement of program objectives were provided by the 1978-79 Title I program. These services fall into two categories: base and optional services. Base services included the following:

- parent volunteer services;
- program assistant services; and
- clothing, shoes, glasses, and hearing aides.

Optional services provided Title I elementary students included the following:

- pupil personnel team services;
- kindergarten aide services;
- parent partner and cultural enrichment services; and
- staff development for classroom teachers and regional resource teacher services.[6]

Base support services were provided to all Title I elementary schools, while optional services were arranged to comprise four option packages, each including three of the four service options. Each school was provided a package of optional services in addition to the base services available to all Title I children.

A lottery system was utilized to allocate optional Title I services packages to elementary schools during the 1978-79 school year. The four packages included the following services:

Package A

- pupil personnel team services
- kindergarten aide services
- parent partner and cultural enrichment services

[6]Parent partner services and cultural enrichment comprised a single optional service, as did staff development and regional resource teacher services.

Package B

- pupil personnel team services
- kindergarten aide services
- staff development for classroom teachers and regional resource teacher services

Package C

- kindergarten aide services
- parent partner and cultural enrichment services
- staff development for classroom teachers and regional resource teacher services

Package D

- pupil personnel team services
- parent partner and cultural enrichment services
- staff development for classroom teachers and regional resource teacher services

A total of 16 schools each were provided Package A services, Package B services and Package D services, while 17 schools were provided Package C services.

Evaluation of the effectiveness of the Title I supplementary instructional services--the program's "treatment"[7]--in meeting program goals was determined through measurement of the students' gains in achievement, acquisition of skills, and improvement of self-concept during the academic year in which they had received service. While the full evaluation of the program includes assessment of the students' progress in all areas of program service,[8] the focus of this report is achievement in reading and mathematics. Subsequent sections of the report include a description of the evaluation design and instrumentation, presentation of the results and discussion of the findings.

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[7]For the purposes of this report, "treatment" is defined as the receipt of laboratory based instructional services in reading or mathematics.

[8]Evaluations of other program components, including the optional packages, are presented in separate reports.

EVALUATION DESIGN

As suggested previously, Title I program evaluation is conducted to determine the extent to which program participation results in improved academic performance. To make this determination, students' achievement following participation must be measured and then compared against the achievement which might have been expected if they had not participated in the program. While assessment of post-program achievement can be made on the basis of post-test achievement test scores, determination of achievement which could have been expected without program participation is less straightforward. For the purposes of evaluating the Washington, D.C., Title I Program, the evaluation design utilized for determining the treatment effect, or the impact on reading and mathematics achievement of program participation, is the norm-referenced model generally referred to as Model A. This model permits assessment of the treatment effect through use of nationally normed achievement tests. A brief overview of the Model A design is presented in the following section.

Model A Design[9]

Model A is one of several design alternatives recently developed by the U.S. Office of Education to facilitate improvement in the evaluation of Title I programs throughout the nation. It is used in situations when a student popula-

[9] A comprehensive description of Model A and other designs available for evaluation of Title I programs is presented in Tallmadge, G., and Wood, C. User's Guide: ESEA Title I evaluation and reporting system. Mountain View, CA: RMC Research Corporation, October 1976. The version of Model A described here is A1, which utilizes norm-referenced tests. A2 uses criterion-referenced tests.

tion is not available to serve as a comparison group to assess treatment effects. Additionally, Model A is sufficiently flexible to permit adaptations appropriate for the unique characteristics of widely disparate school systems.[10]

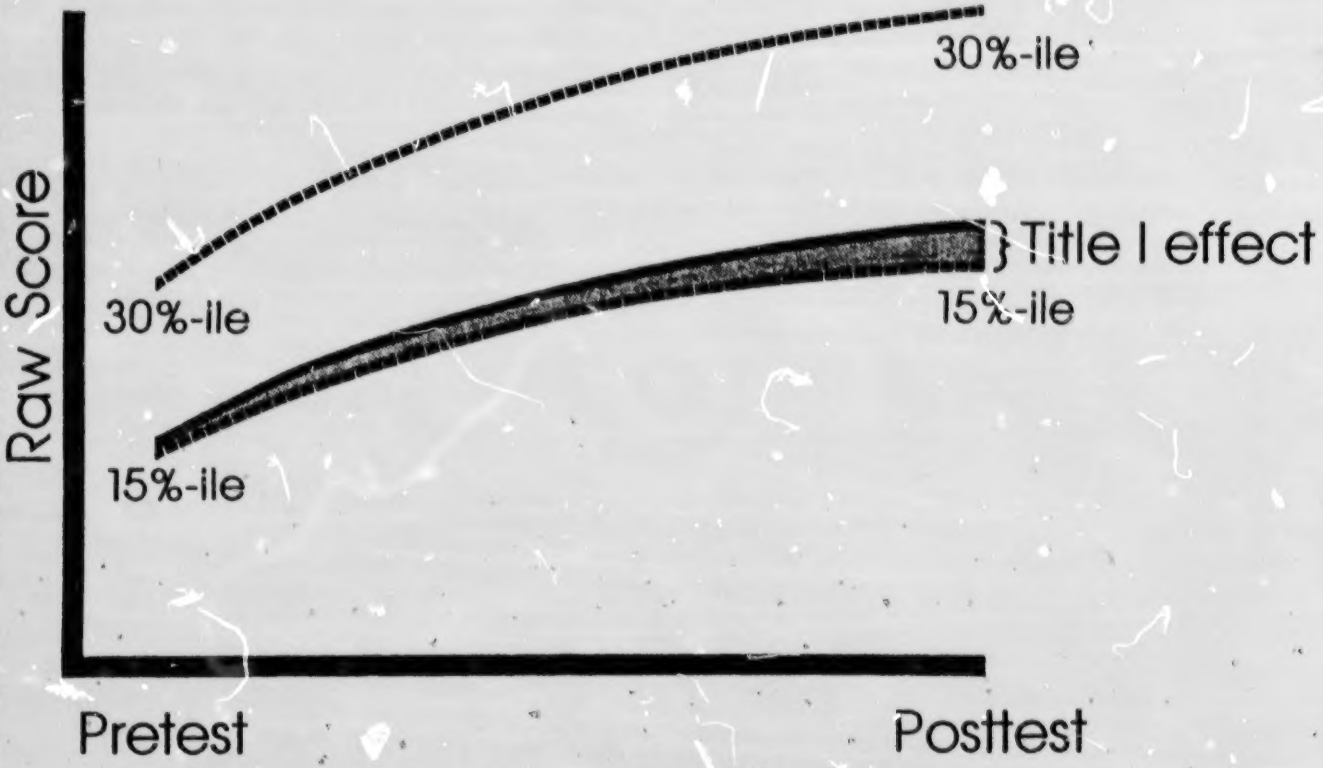
The Model A evaluation design is structured as follows. A normed achievement test is administered to recipients of Title I Program services (i.e., the treatment group) prior to their entry into the program and after a specified period of treatment. Pre and post testing of the treatment group should be conducted at approximately the same time the empirical norming group was tested. This procedure permits determination of the posttest status of the treatment group relative to a representative norm group of children within the same grade level. The norm group hence serves as a nontreatment comparison group.

The basic assumption of this design is that students as a group, if provided comparable instruction, tend to maintain their achievement level relative to the norming group throughout the school year because the group is likely to experience normal growth during that period. That is, the percentile ranking of the average posttest score would correspond to the percentile ranking of the average pretest score (See Figure 1). If this result occurs, the students as a group are considered to have achieved as expected. Conversely, if the percentile ranking of the average posttest scores exceeds the percentile ranking of the average pretest score, the students as a group are considered to have exceeded their expected performance. For students who participate in a Title I program, the norm-referenced model assumes that performance which exceeds expectations is attri-

[10] For example, considerable latitude exists in the choice of instruments, logistics of test administration, etc.

Figure 1

Assumed Title I Effect in Model A



butable to the supplementary reading and mathematics instruction provided by the Title I program. Within this framework, the treatment effect attributed to the Title I program is the observed posttest performance minus the expected no-treatment posttest performance, which can be formulated as follows:

Treatment effect = Observed Title I posttest (treatment) performance − Expected posttest (no-treatment) performance

In this report, results are presented in terms of achievement scores that have been transformed from percentiles into normal curve equivalent (NCE) scores.[11] The expected posttest no-treatment performance of the Title I students is their average pretest achievement NCE score, and the effect of program participation is indicated by the differences between the average pretest and average posttest achievement NCE scores of program participants.

Use of Model A to estimate program impact requires that the following assumptions be satisfied:

1. The pretest was not used to select program participants;
2. Achievement tests were administered at times corresponding to the periods when the test was normed;
3. The same form and level of the achievement test were used for both pretest and posttest;
4. Analysis was limited to students for whom both pretest and posttest scores were available;
5. At least two-thirds of the program participants were included in the analysis; and
6. At least two-thirds of program participation occurred in the period between the pretest and posttest.

For the most part, the data sets utilized in the Model A analysis met

[11] Appendix B provides a discussion of NCE scores.

these assumptions. Program participants were selected based on their previous year's posttest achievement scores as well as on other factors. In connection with time of test administration, no fall empirical norms exist for grades two, three, and seven of the CTBS; consequently, extrapolated norms were used for these grades.[12] For grade one in the fall, and grades one, two, three and seven in the spring, empirical norms are available and test administration occurred in acceptable proximity to the test's empirical norming periods.

Table 2 indicates the form and level of the CTBS administered to Title I students during the fall and spring testing periods. As this information indicates, test levels administered to each grade remained the same for pretest and posttest, thus fulfilling part of the third Model A assumption. In regard to test forms, however, changes were made from pretest to posttest in the form administered to grades three, four, and seven. Technically, therefore, this assumption of the model was not met for these grades, although according to the test publisher Forms S and T are essentially equivalent because they were statistically equated by the publisher in 1975.[13]

Only those students for whom both pretest and posttest scores were available have been included in this analysis, with the additional constraint that for these students at least two-thirds of their supplementary instruction in reading and mathematics occurred between the two testing periods. Finally,

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[12]While this procedure of using extrapolated norms is not ideal, it is the only alternative with tests for which empirical norming at a particular time has not occurred.

[13]Test coordinator's handbook (expanded edition): Comprehensive Tests of Basic Skills. Monterey, CA: CTB/McGraw-Hill, 1976.

Table 2

Form and Level of the CTBS Administered to Title I Students During the Fall and Spring Testing Periods (1978-79)

Grade	Fall (pretest)		Spring (posttest)	
	Form	Level	Form	Level
1	S	B	S	B
2	S	C	S	C
3	S	1	T	1
4	S	2	T	2
7	S	3	T	3

Table 3

Distribution of Title I Served Students with Matched Data

Grade	Reading served			Math served		
	Actual students served[a]	Included in analysis	Percent	Actual students served[a]	Included in analysis	Percent
1	1,943	1,277	65.7	2,000	974	48.7
2	1,843	1,162	63.0	1,360	943	69.3
3	2,248	1,091	48.5	1,693	720	42.5
4	902	123	13.6	----	----	----
7	1,606	172	10.7	1,166	97	8.3
TOTAL	8,542	3,825	44.8	6,219	2,734	44.0

[a]Source: Service data provided by Title I program office.

somewhat fewer than two-thirds of reported participants were included in the analysis. Table 3 shows the numbers and percentages of Title I students for whom matched data were available. The problem of sample size is discussed at length in a subsequent section of this report (Description of the Student Population).

Instrumentation

Two instruments were utilized to collect data required for conduct of the Model A analysis of the D.C. Title I program. Achievement scores were derived from the Comprehensive Tests of Basic Skills (CTBS) while information concerning students' Title I program eligibility and participation, grade level, etc., was derived from the Student Information Form (SIF), a teacher-completed questionnaire developed specifically for the D.C. Title I Program. A brief description of these instruments is presented in this section.

Comprehensive Tests of Basic Skills (CTBS). The CTBS is a group-administered series of achievement tests for kindergarten through twelfth grade students. The CTBS achievement battery is designed to measure systematically, on a national basis, attainment of knowledge in reading and mathematics in addition to those skills areas which the publishers believe to be prerequisite to effective studying and learning in school.

The CTBS for students in kindergarten through grade two assesses three basic skills areas: reading, language arts, and mathematics. Among the reading subtests administered at various grade levels were word recognition, letter sounds, reading comprehension and vocabulary. Language arts subtests included language expression, spelling, and language mechanics; and mathematics subtests included computation and concepts and applications.

The CTBS for third, fourth and seventh grade students includes five basic skills areas, three of which, reading, language arts, and mathematics, were administered for this evaluation. Reading subtests included reading comprehension; language arts subtests included spelling, language mechanics and language expression; and mathematics subtests included computation and concepts and applications.

Student Information Form (SIF). The SIF was developed to collect information from teachers about individual students concerning their background, home environment, and other nonacademic and demographic factors. This form is reviewed and revised each year. School-related information collected on the SIF includes grade levels and grades repeated, Title I eligibility and participation, school attendance information, health status, and language and communications problems. Other information collected includes sex, behavioral patterns (withdrawn behavior, aggressiveness, etc.) and level of family support manifested.

Description of the Student Population

Data were collected from students in grades one, two, three, four and seven in the Washington, D.C., public schools during the 1978-79 academic year. The Model A analysis required that the following data be available for each student included in the analysis: (1) pretest administration of the CTBS; (2) posttest administration of the CTBS; and (3) teacher-reported data on each individual student. Any student for whom any of these data were missing was omitted from one or more of the analyses. Table 4 shows the number of students with data from each source.

Table 4

Number of Students[a] in Each File

File	Number of cases
SIF	18,020
CTBS pretest	25,921
CTBS posttest	25,504

[a]Includes both Title I and non-Title I students.

The data tape containing one of the three data sources was edited to select and condense the necessary data. Several different procedures were utilized for matching the various datasets, with no procedure yielding overall the desired rate of 67 percent successful matches. Finally, a combination of procedures was decided upon to give the highest possible match rate. This combination involved using a computer match as the primary technique, generating lists of unmatched students and hand matching as many students as possible from these lists. Table 5 presents the number of students matched by each technique.

Table 5

Number of Students[a] Matched in Each Stage of Two-stage Match

Matches	n
Stage 1 (computer)	8,119
Stage 2 (hand)	1,620
Total Matched	9,739

[a]Includes both Title I and non-Title I students.

Table 6 lists the numbers of students with matches between any of the data files. Through the use of this combination match, overall match rates of 44.8 percent of the reading-served students and 44.0 percent of the math-served students were achieved. These match rates are shown in Table 3. As these data show, percentages of cases available for analysis were relatively high for grades one and two reading, with only grade two mathematics yielding the desired rate of at least 67 percent successful matches. Conversely, match rates for seventh graders were extremely low.

Table 6

Number of Students[a] Matched Between Files

Types of Match	Number of cases
SIF - CTBS pre- CTBS post	5,739
SIF - CTBS pre	2,116
SIF - CTBS post	2,409
CTBS pre - CTBS post	1,284
SIF unmatched	3,756
CTBS pre unmatched	12,782
CTBS post unmatched	13,432

[a]Includes both Title I and non-Title I students.

Analysis based on the total number of cases for which matched data were available (see Table 3) is presented in the next section of this report.

EVALUATION RESULTS

Results of the Model A analysis of the D.C. Title I program are presented in this section by grade. Included is the formal Model A analysis of treatment effect as estimated through a comparison of pre and posttest reading and mathematics scores on the CTBS administered in fall and spring testing cycles to students from grades one, two, three and seven who received Title I services during the 1978-79 academic year. Additionally, an analysis of the fourth-grade pilot project in reading is presented. Finally, results of a separate analysis of students' achievement in grades one, two, and three distributed according to whether or not they were repeaters are presented.

The rationale for the repeaters/nonrepeaters analysis is as follows. For the most part, students in Washington, D.C., who have repeated a grade are selected for the Title I program participation regardless of their qualification on such other variables as achievement. It was hypothesized that since repeaters exhibit differing pre-entering behavior from nonrepeating students, their selection on the basis of having repeated might well introduce a bias into the analysis of program-related achievement. That is, the possibility exists that the lower achievement levels of repeaters might cause a lower overall reported achievement level of program participants than might be found if repeaters were separated out for analysis.

Results of both analyses are presented in this section with a discussion of the implications and recommendations of the analysis presented in the concluding section of this report.

Achievement Gains Among First Graders

Data reported in Table 7 and Figure 2 indicate the estimated Title I program treatment effects in reading and mathematics for first graders who received Title I supplementary instruction during 1978-79. The mean gain in reading achievement for a group of 1,277 first grade students was 1.66 NCEs. In mathematics, the mean achievement gain for 974 students was 7.19 NCEs.

Table 7

Estimated Treatment Effect on Reading and Mathematics Achievement Among First Graders Receiving Title I Supplementary Instructional Services (1978-79)

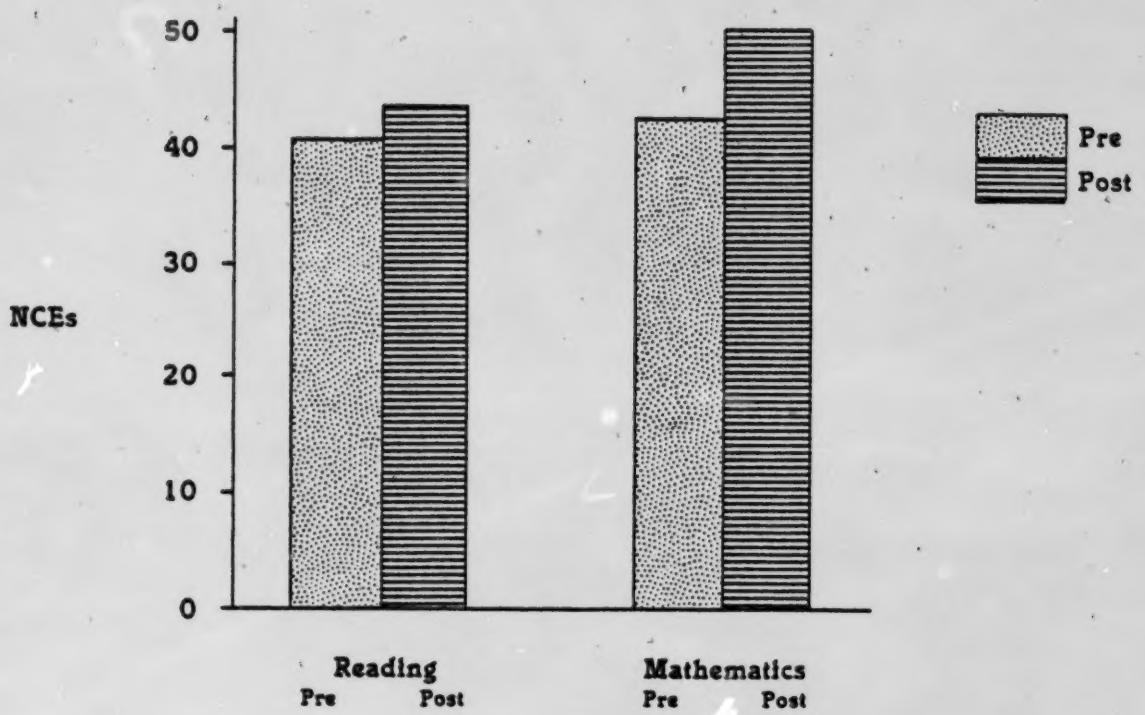
Subject area	n	Average pretest (NCE)	(%ile)	Average posttest (NCE)	(%ile)	Estimated treatment effect (NCE)	T	p
Reading	1277	41.64	35.2	43.30	37.0	1.66	3.10	<.002
Mathematics	974	42.82	37.0	50.01	50.0	7.19	11.02	<.0001

Post-treatment reading and mathematics achievement effects are shown separately in Table 8 and Figure 3 for first graders identified as repeaters and nonrepeaters. In reading, the repeater group lost nearly four NCEs from pre to posttest, while the nonrepeaters gained 3.71 NCEs, which represents an increase of more than two NCEs over the group as a whole (see Table 7). Thus, the inclusion of repeaters in the student population forming the basis for the Model A analysis of first graders was found to have a substantial depressing effect on total group achievement gain in reading.

In mathematics, the first grade nonrepeaters group (n = 719) achieved substantially larger gains than either the total group (n = 974) or the repeater group (n = 237). Mean gains were 9.44 for nonrepeaters versus 7.19 for the total group and 0.77 for repeaters.

Figure 2

Pre and Post Differences on the CTBS Among First Graders



	Total Reading		Mathematics	
	Pre	Post	Pre	Post
$\bar{X}$	41.64	43.30	42.82	50.01
S.D.	17.99	18.73	15.29	20.60
Difference	1.66		7.19	
N	1277		974	
T	3.10		11.02	
p	< .002		< .0001	

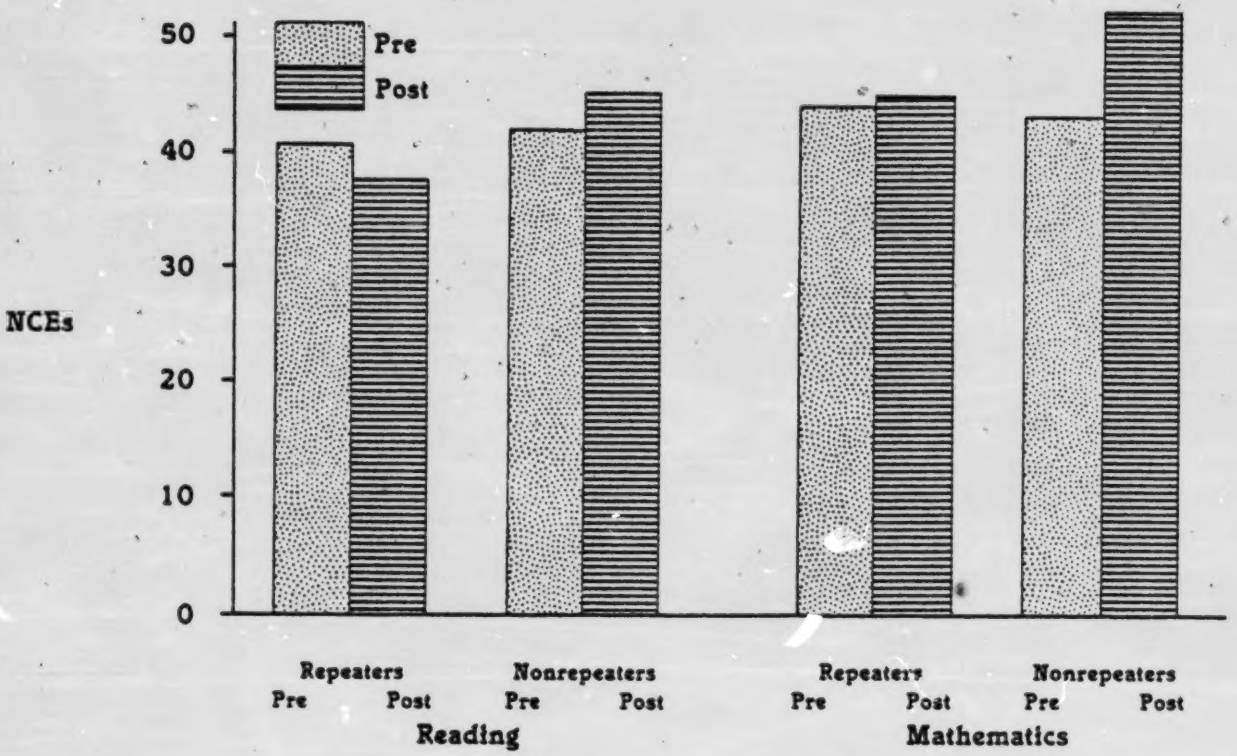
Table 8

Estimated Treatment Effect on Reading and Mathematics Achievement For First Grade Repeaters and Nonrepeaters Receiving Title I Supplementary Instructional Services (1978-79)

Subject area / Type of student	n	Average pretest (NCE)	Average pretest (%ile)	Average posttest (NCE)	Average posttest (%ile)	Estimated treatment effect (NCE)	T	p
Reading								
Repeaters	331	41.19	33.5	37.21	26.8	-3.99	-4.28	<.0001
Nonrepeaters	924	41.94	35.2	45.66	42.5	3.71	5.83	<.0001
Mathematics								
Repeaters	237	44.27	38.8	45.04	40.6	0.77	0.67	<.50
Nonrepeaters	719	42.56	37.0	52.0	53.8	9.44	12.69	<.0001

Figure 3

Pre and Post Differences on the CTBS Among First Grade Repeaters and Nonrepeaters



	Total Reading				Mathematics			
	Repeaters		Nonrepeaters		Repeaters		Nonrepeaters	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
$\bar{X}$	41.19	37.21	41.94	45.66	44.27	45.04	42.56	52.0
S.D.	17.70	18.17	18.08	18.41	15.21	19.45	15.36	20.53
Difference	-3.99		3.71		0.77		9.44	
N	331		924		237		719	
T	-4.28		5.83		0.67		12.29	
p	< .0001		< .0001		< .50		< .0001	

Achievement Gains Among Second Graders

Table 9 and Figure 4 present the estimated Title I program treatment effects on reading and mathematics for second graders receiving Title I supplementary instruction during 1978-79. The mean gain in reading achievement for a group of 1,162 second graders was 9.68 NCEs. In mathematics, the mean achievement gain for 943 students was 11.34 NCEs.

Table 9

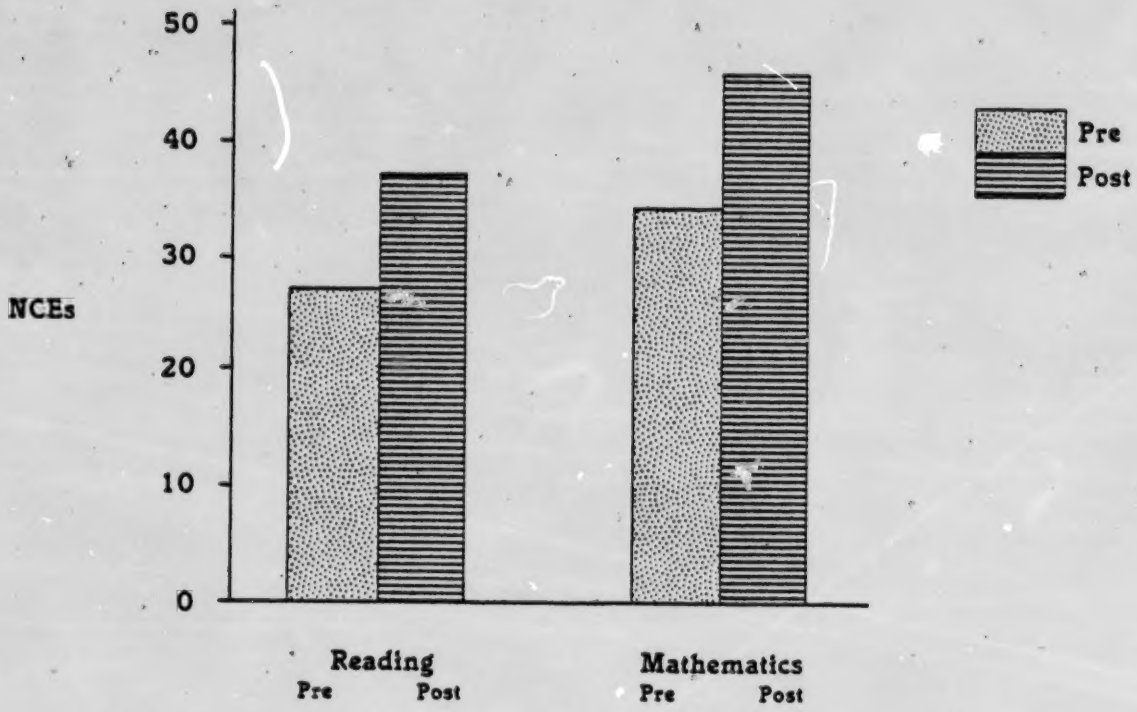
Estimated Treatment Effect on Reading and Mathematics Achievement Among Second Graders Receiving Title I Supplementary Instructional Services (1978-79)

Subject area	n	Average pretest (NCE)	Average pretest (%ile)	Average posttest (NCE)	Average posttest (%ile)	Estimated treatment effect (NCE)	T	p
Reading	1162	27.46	13.7	37.14	26.8	9.68	21.61	<.0001
Mathematics	943	34.61	23.8	45.95	42.5	11.34	20.58	<.0001

Data presented in Table 10 and Figure 5 show the post-treatment achievement effects separately for second graders identified as repeaters and nonrepeaters. While the total group gain in reading was 9.68 NCEs (see Table 9), the gain for second grade nonrepeaters was 10.95, with repeaters averaging a gain of 5.25 NCEs in reading achievement. Again, therefore, repeaters' achievement scores had a somewhat depressing effect on total group gain. In mathematics, a similar pattern was observed. Total group gain among second graders in mathematics was 11.34 NCEs; nonrepeaters gained 12.70 NCEs, and repeaters gained 5.81 NCEs from pretest to posttest.

Figure 4

Pre and Post Differences on the CTBS Among Second Graders



	Total Reading		Mathematics	
	Pre	Post	Pre	Post
$\bar{X}$	27.46	37.14	34.61	45.95
S.D.	16.31	17.98	16.09	19.47
Difference	9.68		11.34	
N	1162		943	
T	21.61		20.58	
p	< .0001		< .0001	

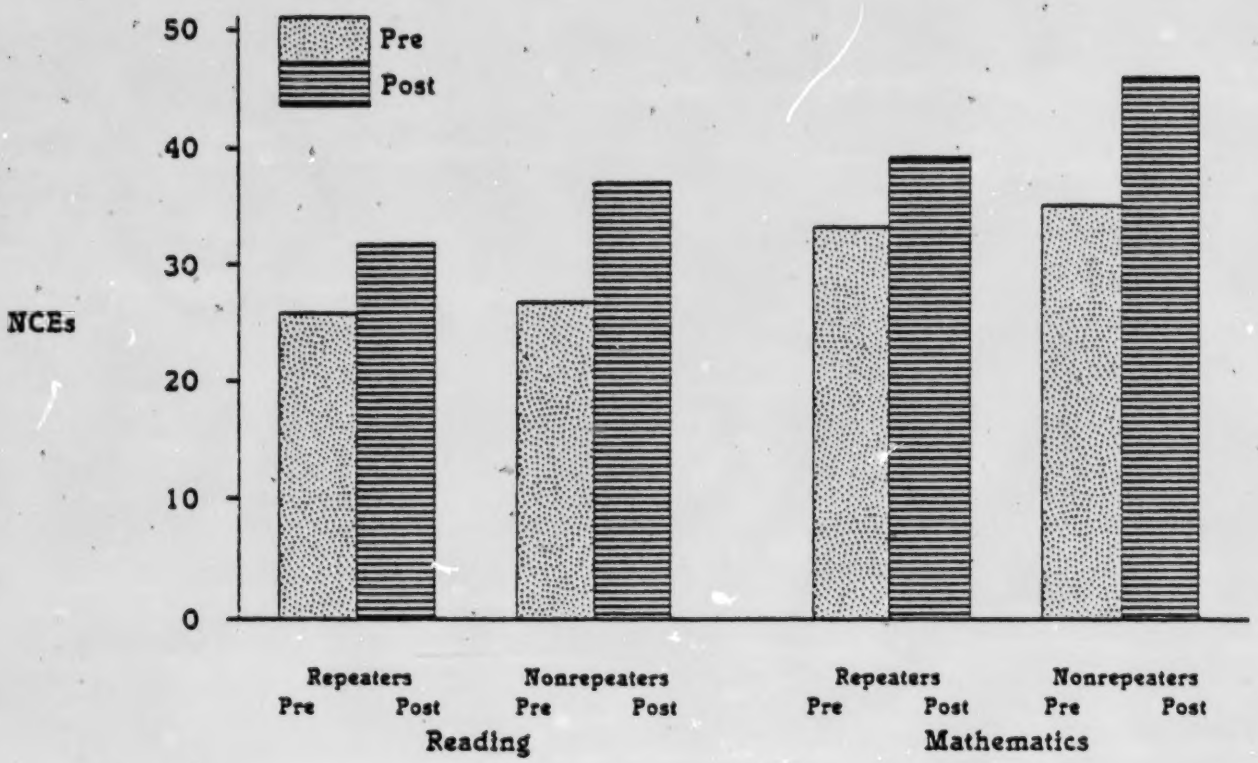
Table 10

Estimated Treatment Effect on Reading and Mathematics Achievement For Second Grade Repeaters and Nonrepeaters Receiving Title I Supplementary Instructional Services (1978-79)

Subject area / Type of student	n	Average pretest (NCE)	Average pretest (%ile)	Average posttest (NCE)	Average posttest (%ile)	Estimated treatment effect (NCE)	T	p
Reading								
Repeaters	210	26.39	12.7	31.64	19.6	5.25	4.90	<.0001
Nonrepeaters	878	27.86	14.8	38.81	30.1	10.95	21.68	<.0001
Mathematics								
Repeaters	174	33.55	22.4	39.36	30.1	5.81	4.90	<.0001
Nonrepeaters	706	35.12	23.8	47.81	46.2	12.70	20.12	<.0001

Figure 5

Pre and Post Differences on the CTBS Among Second Grade Repeaters and Nonrepeaters



	Total Reading				Mathematics			
	Repeaters		Nonrepeaters		Repeaters		Nonrepeaters	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
$\bar{X}$	26.39	31.64	27.86	38.81	33.55	39.36	35.12	47.81
S.D.	14.05	17.84	17.07	17.85	16.06	19.75	16.09	18.91
Difference	5.25		10.95		5.81		12.70	
N	210		878		174		706	
T	4.90		21.68		4.90		20.12	
p	< .0001		< .0001		< .0001		< .0001	

Achievement Gains Among Third Graders

The estimated program treatment effects on reading and mathematics for third graders are presented in Table 11 and Figure 6. The mean gain in reading for 1,091 third grade students was 3.08 NCEs, while the mean gain in mathematics for a group of 720 third graders was 10.81 NCEs.

Table 11

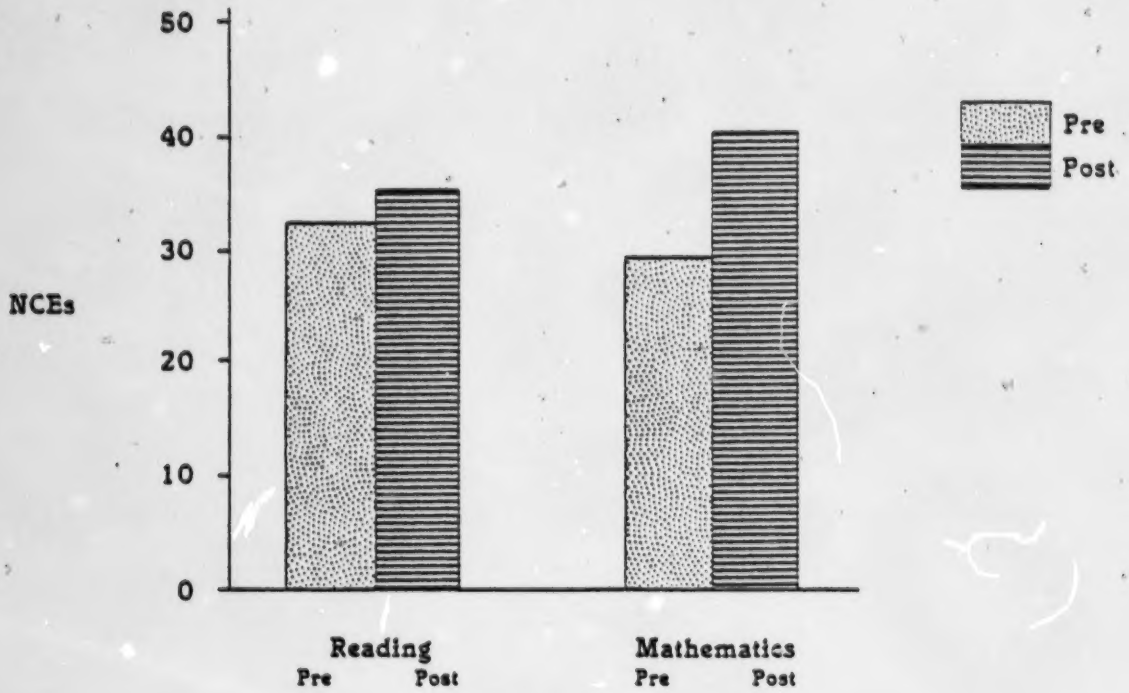
Estimated Treatment Effect on Reading and Mathematics Achievement Among Third Graders Receiving Title I Supplementary Instructional Services (1978-79)

Subject area	n	Average pretest (NCE)	Average pretest (%ile)	Average posttest (NCE)	Average posttest (%ile)	Estimated treatment effect (NCE)	T	p
Reading	1091	32.43	19.6	35.51	25.3	3.08	7.39	<.0001
Mathematics	720	29.32	15.9	40.13	31.7	10.81	22.62	<.0001

Data presented in Table 12 and Figure 7 indicate the estimated post-treatment effects separately for third grade repeaters and nonrepeaters who received Title I supplementary instructional services during 1978-79. As shown in Table 11, the total group gains for third graders were 3.08 NCEs in reading and 10.81 NCEs in mathematics. For repeaters, gains were 0.07 NCEs in reading and 8.71 NCEs in mathematics, while nonrepeaters gained 3.56 in reading and 11.18 NCEs in mathematics. Repeaters' test scores therefore had a depressing effect on total group achievement, although due to the relatively smaller number of repeaters in the third-grade sample, this effect was not so great as that observed for grades one and two.

Figure 6

Pre and Post Differences on the CTBS Among Third Graders



	Total Reading		Mathematics	
	Pre	Post	Pre	Post
$\bar{X}$	32.43	35.51	29.32	40.13
S.D.	12.35	14.97	13.10	14.83
Difference	3.08		10.81	
N	1091		720	
T	7.39		22.62	
p	< .0001		< .0001	

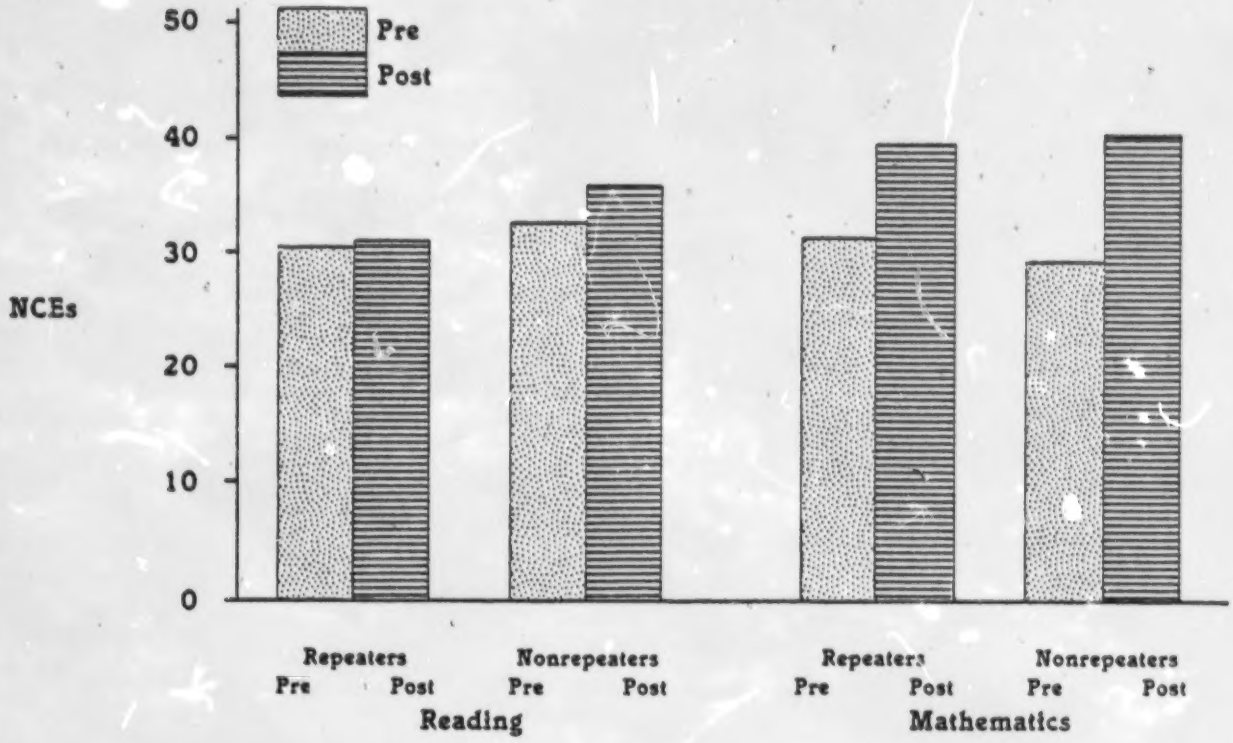
Table 12

Estimated Treatment Effect on Reading and Mathematics Achievement For Third Grade Repeaters and Nonrepeaters Receiving Title I Supplementary Instructional Services (1978-79)

Subject area / Type of student	n	Average pretest (NCE)	Average pretest (%ile)	Average posttest (NCE)	Average posttest (%ile)	Estimated treatment effect (NCE)	T	p
Reading								
Repeaters	126	30.20	17.1	30.27	17.1	0.07	0.06	<.96
Nonrepeaters	923	32.77	21.0	36.33	25.3	3.56	7.97	<.0001
Mathematics								
Repeaters	91	30.83	18.4	39.54	31.7	8.71	6.97	<.0001
Nonrepeaters	606	29.13	15.9	40.32	31.7	11.18	21.28	<.0001

Figure 7

Pre and Post Differences on the CTBS Among Third Grade Repeaters and Nonrepeaters



	Total Reading				Mathematics			
	Repeaters		Nonrepeaters		Repeaters		Nonrepeaters	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
$\bar{X}$	30.20	30.27	32.77	36.33	30.83	39.54	29.13	40.32
S.D.	11.54	14.27	12.45	14.95	13.28	14.83	13.05	14.93
Difference	0.07		3.56		8.71		11.18	
N	126		923		91		606	
T	0.06		7.97		6.97		21.28	
p	< .96		< .0001		< .0001		< .0001	

Reading Achievement Gains Among Fourth Graders

In 1978-79, the Title I program operated a pilot program in reading for a sample of fourth grade students who met the Title I eligibility requirements. Table 13 and Figure 8 present data on the impact of Title I participation among this group of students. As shown, the mean gain in reading achievement among fourth graders who participated in the pilot program was 7.84 NCEs. Due to the small number of students for whom data were available, an analysis of repeaters versus nonrepeaters was not conducted for the fourth grade sample.

Table 13

Estimated Treatment Effect on Reading Achievement Among Fourth Graders Receiving Title I Supplementary Instructional Services (1978-79)

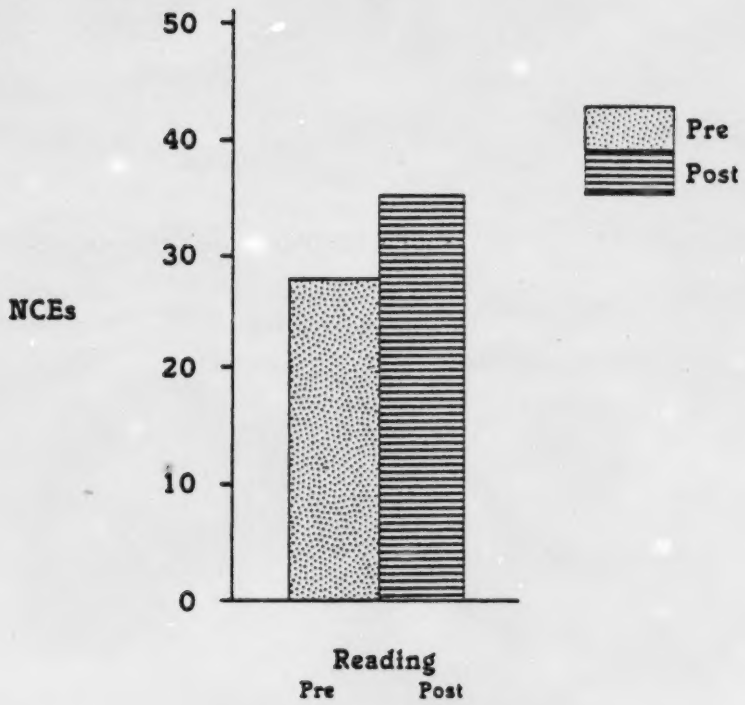
Subject area	n	Average pretest (NCE)	(%ile)	Average posttest (NCE)	(%ile)	Estimated treatment effect (NCE)	T	p
Reading	123	28.22	14.8	36.06	25.3	7.84	5.56	<.0001

Achievement Gains Among Seventh Graders

The estimated program treatment effects on reading and mathematics for seventh graders who received Title I supplementary instructional services during 1978-79 are presented in Table 14 and Figure 9. The mean estimated treatment effect on reading was -0.63 NCEs, while the mean gain in mathematics was 2.35 NCEs. It should be noted that the number of students available for analysis at the seventh grade level was quite small; data were available on only 11 percent of seventh graders receiving reading services in 1978-79 and on only 7.2 percent of students receiving supplementary mathematics instruction. Consequently, the analysis of treatment effect reported for seventh graders cannot be viewed with confidence. (In fact, only one of the reported treatment effects was found to be statistically significant.) Additionally, the small

Figure 8

Pre and Post Differences on the CTBS Among Fourth Graders



	Total Reading	
	Pre	Post
$\bar{X}$	28.22	36.06
S.D.	14.97	21.45
Difference	7.84	
N	123	
T	5.56	
p	< .0001	

number of cases available for analysis precluded examination of the different achievement among repeaters and nonrepeaters.

Table 14

Estimated Treatment Effect on Reading and Mathematics Achievement Among Seventh Graders Receiving Title I Supplementary Instructional Services (1978-79)

Subject area	n	Average pretest (NCE)	Average pretest (%ile)	Average posttest (NCE)	Average posttest (%ile)	Estimated treatment effect (NCE)	T	p
Reading	172	30.80	18.4	30.17	17.1	-0.63	-0.76	< .45
Mathematics	97	29.92	17.1	32.28	19.6	2.35	2.10	< .04

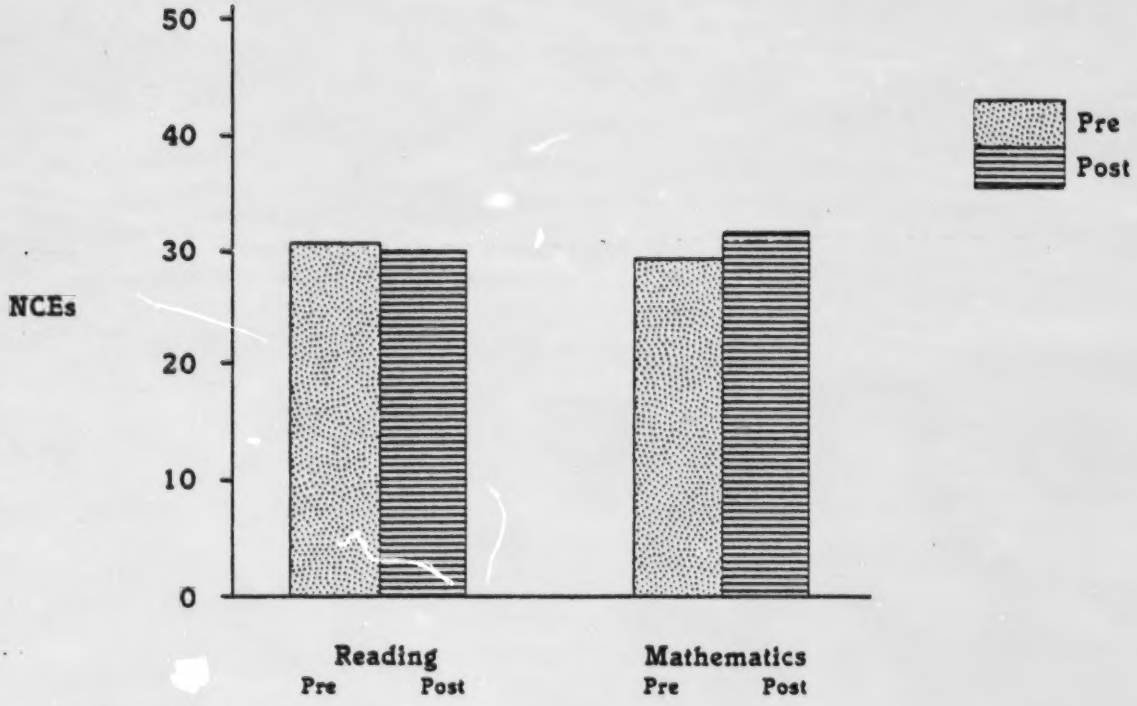
Comparison of Program Effects for 1977-78 and 1978-79

In order to examine the relative progress of the Title I program in improving the academic achievement among program participants, a comparison was made between the 1978-79 achievement gains and those reported for the 1977-78 Title I program. Achievement gains for reading are presented in Table 15. As shown, student reading achievement gains in 1978-79 exceeded those reported for 1977-78 with the exception of grade seven.[14] Reading gains for 1978-79 were generally about one NCE higher than those reported in 1977-78. As indicated previously, the small number of students in the seventh grade sample severely limits the confidence with which those results can be viewed.

[14]Since the fourth grade program was implemented in 1978-79, no data were available for the previous year.

Figure 9

Pre and Post Differences on the CTBS Among Seventh Graders



	Total Reading		Mathematics	
	Pre	Post	Pre	Post
$\bar{X}$	30.80	30.17	29.92	32.28
S.D.	14.02	14.83	16.01	16.09
Difference	-0.63		2.35	
N	172		97	
T	-0.76		2.10	
p	< .45		< .04	

Table 15

Title I Program Impact on Reading Achievement: Comparison of Estimated Treatment Effect (in NCEs) Among Students Receiving Title I Services in 1977-78 and 1978-79

	(1978-79)		(1977-78)	
Grade	n	Mean gain (NCE)	n	Mean gain (NCE)
1	1277	1.66	1649	.60
2	1162	9.68	1365	8.76
3	1091	3.08	1211	2.23
4	123	7.84	---	---
7	172	-.63	643	2.82

In mathematics, gains were higher in 1978-79 for students in grades one, two, and three (Table 16). For first graders, the mean gain was about one NCE higher than in 1977-78. For second graders, the 1978-79 gain exceeded that of 1977-78 by almost three NCEs, and for third graders the gain was almost two NCEs higher. As with reading, the small number of students in the seventh grade sample limits the utility of comparisons for that grade.

For grades with adequate data (grade one, two, and three), therefore, achievement gains in 1978-79 were consistently higher than those reported for 1977-78. Further, gains in mathematics achievement were found to be relatively higher than those observed for reading.

Table 16

Title I Program Impact on Mathematics Achievement: Comparison of Estimated Treatment Effect (in NCEs) Among Students Receiving Title I Services in 1977-78 and 1978-79

	(1978-79)		(1977-78)	
Grade	n	Mean gain (NCE)	n	Main gain (NCE)
1	974	7.19	1578	6.15
2	943	11.34	1294	8.50
3	720	10.81	1171	8.99
7	97	2.35	573	6.47

CONCLUSIONS AND IMPLICATIONS

Program Effectiveness

As has typically been the case with most Title I programs, the D.C. Title I program has traditionally presented program objectives relevant to reading and mathematics achievement in terms of grade equivalents.[15] However, since the implementation of new Title I reporting and evaluation requirements by the Office of Education (the publication of final regulations occurred in October 1979), the use of grade equivalents to measure program effectiveness has become obsolete. The Office of Education now requires that program achievement gains be reported in a new metric, called normal curve equivalents (NCEs).[16]

In response to this change, the D.C. Title I program has restated its achievement-related objectives in terms of NCEs. While this change will not be implemented until the 1979-80 school year, it seems reasonable to examine the effectiveness of the 1978-79 program in terms of the new objectives, particularly because this year's evaluation findings have been reported in NCEs. Table 17 summarizes the 1978-79 reading and mathematics achievement gains by grade and compares these gains with program objectives. As these data indicate, student achievement in reading and mathematics exceeded program objectives at all grade levels except grade seven. Student achievement gains, as measured against program objectives, were particularly high

[15] The 1978-79 Title I program objectives are listed on page 4 of this report.

[16] A discussion of NCEs is presented in Appendix B of this report.

Table 17

1978-79 Title I Reading and Mathematics Achievement Gains in NCEs Compared with 1979-80 Program Objectives by Grade

Subject area by grade	1979-80 program objective (NCEs)	1978-79 mean achievement gain (NCEs)
Reading		
Grade 1	1	1.66
2	3	9.68
3	3	3.08
4	-[a]	7.84
7	3	-.63
Mathematics		
Grade 1	3	7.19
2	5	11.34
3	5	10.81
7	5	2.35

[a]Program objectives were not articulated for the fourth grade pilot project.

for grades two and four reading and for grades one, two and three mathematics. The conclusion can be reached, therefore, that for all elementary grades the 1978-79 Title I program met, and in the previously mentioned instances substantially exceeded, program objectives for student achievement in reading and mathematics.

The only areas in which program objectives were not achieved were seventh grade reading and mathematics. As indicated in the previous chapter, a partial explanation for this finding may be the small number of cases available for analysis. Because of inherent differences between elementary and secondary school settings and instructional arrangements, difficulty has always been experienced in collecting data of adequate quality to evaluate the seventh grade program. In order to assure the accuracy of seventh grade

evaluation findings in the future, additional effort should be expended on data collection at the junior high school level.

Even within the constraints of data quality, however, the relatively low treatment effects reported for seventh grade students suggest the possibility that programmatic action may be in order. Such action might take the form of additional resources or possibly the concentration of resources at the late elementary grades where student movement (from class to class) is still better controlled than it can be in junior high school. Any such decisions are of course properly the province of Title I program decision-makers.

Data Collection and Processing

As has occurred in previous years, a number of data-related problems arose during the evaluation which influenced the numbers of students who could be included in the Model A analysis. In order to fulfill the Model A assumptions, these problems need resolution. Since one problem had to do with student identification numbers, one approach may be to implement a control system to assure that all identification numbers match pre and post as well as to assure that the maximum number of matched records exists.

A second approach to this problem may be to re-examine and refine test and questionnaire distribution and receipt procedures. Part of this effort might be the provision of additional training and orientation at all levels included in the data collection process (classroom, school, region, and central receipt agency). These efforts may be expected to make a substantial contribution to assuring that the number of students available for analysis in the future is adequate to meet U.S.O.E. guidelines.

APPENDIX A

Title I Schools
(1978-79)

Title I Schools
(1978-79)

Elementary Schools

Adams
Aiton
Amidon
Birney
Bowen
Bruce-Monroe
Bryan
Cleveland
Cook, J.F.
Cooke, H.D.
Draper
Drew
Emery
Fletcher-Johnson
Friendship
Gage-Eckington
Garfield
Garrison
Giddings
Goding
Green
Harris
Harrison
Hendley
Kenilworth
Ketcham
Kimball
Langston
Lenox
Lewis
Lovejoy
Ludlow Taylor
Malcolm X
Meyer
Miner
Montgomery
Moten
Nalle
Park View
Plummer
Raymond
Reed, Marie
Richardson
Savoy
Seaton
Shadd
Simon
Simmons
Stanton
Syphax
Terrell, M.C.
Thomas
Thomson
Tubman
Turner
Tyler
Van Ness
Walker-Jones
Washington-Highland
Watkins
Weatherless
Webb
Wheatley
Wilkinson
Wilson, J.O.
Young

Junior High Schools

Banneker
Browne
Douglass
Evans
Francis
Garnet-Patterson
Hart
Hine
Jefferson
Johnson
Miller
Roper
Shaw
Stuart
Terrell
Woodson, C.G.

Private School Sites

Holy Comforter
Holy Name
Holy Redeemer
Our Lady Queen of Peace
Our Lady Perpetual Help
St. Martin's
Sts. Paul and Augustine

APPENDIX B

Conversion to
Normal Curve Equivalents

Any national assessment of program impact requires that the data from the numerous projects being evaluated be comparable.* Typically, local educational agencies enjoy generous autonomy in the selection of objectives, evaluation methodology, and instrumentation. Hence, the major logistical difficulty for a national evaluation team resides in aggregating various types of scores derived from different tests.

The normal curve equivalent (NCE) presents one solution to this dilemma. Two basic assumptions must, however, be satisfied in order to utilize this metric. First, the tests to be compared must measure, at least approximately, if not actually, the same sets of skills. Several recent research efforts such as the Anchor Test Study (Loret, Seder, Bianchini, and Vale, 1972) indicate that the intercorrelations among the eight most widely used reading achievement tests generally register 0.95 or better. Another study (Roudabush, 1975) shows that these results extend to comparisons between criterion-referenced (CRT) and norm-referenced (NRT) tests; this research effort found the correlation between a CRT and NRT to be equivalent to that between the two alternate forms of the NRT.

The second assumption which must be made relates to the implications and "generalizability" of gains in achievement test scores. Any two tests which purportedly measure a specific ability such as reading comprehension do not necessarily contain essentially identical items or objectives. Nonetheless, each test can be expected to contain a subset of items or objectives which do overlap with respect to the construct which they address. In order to use NCEs, an increase in the general ability measured by the two tests must be assumed

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*This appendix draws heavily from "The Normal Curve Equivalent: A Metric to Measure Instructional Project Impact," by Alice Chiang and Larry D. Rosen.

to be directly indicated by the gain represented in any subset of items or objectives claiming to measure that general ability.

The metric proposed by various researchers as well as by USOE is the NCE. It is a simple, standardized transformation similar to both a Z-score and a T-score. The NCE is distributed normally about a mean of 50 with a standard deviation of 21.06. To convert a raw score to an NCE, a Z-score is obtained using the following formula:

$$Z = \frac{X - \mu}{\sigma}$$

where X = observed or raw score;

μ = population mean; and

σ = population standard deviation.

The Z-score can then be easily transformed into an NCE by this operation:

$$NCE = (21.06)Z + 50$$

If the raw test scores can be translated into percentiles using appropriate tables supplied by the test publisher, then the NCEs representing the raw scores may easily be determined by using a conversion table of percentiles-to-NCEs such as Table B.1. There are also conversion tables available which list the NCE equivalent to every percentile ranging from 0.0 to 100.0 by increments of one-tenth.

Another method for translating percentiles to NCEs is to find the Z-score in a table (such as B.2) of the cumulative normal distribution for various standardized values. More extensive and precise tables can be found with numbers accurate to many decimal places; however, this table is suitable for the purposes of this discussion. A percentile is actually a decimal fraction with a base equal to 100. Hence, a percentile score of 24.2 percent is equivalent to 0.2420. Using a cumulative normal distribution table, we see that the area under the normal curve equal to 0.2420 corresponds to a Z-score of -0.70. This

Table 8.1

Normal Curve Equivalent to Percentile Conversion Table

NCE	Percentile	NCE	Percentile	NCE	Percentile	NCE	Percentile
1	1.0	26	12.7	51	51.9	76	89.2
2	1.1	27	13.7	52	53.8	77	90.0
3	1.3	28	14.8	53	55.7	78	90.8
4	1.4	29	15.9	54	57.5	79	91.6
5	1.6	30	17.1	55	59.4	80	92.3
6	1.8	31	18.4	56	61.2	81	92.9
7	2.1	32	19.6	57	63.0	82	93.6
8	2.3	33	21.0	58	64.8	83	94.1
9	2.6	34	22.4	59	66.5	84	94.7
10	2.9	35	23.8	60	68.3	85	95.2
11	3.2	36	25.3	61	69.9	86	95.6
12	3.6	37	26.8	62	71.6	87	96.1
13	3.9	38	28.4	63	73.2	88	96.4
14	4.4	39	30.1	64	74.7	89	96.8
15	4.8	40	31.7	65	76.2	90	97.1
16	5.3	41	33.5	66	77.6	91	97.4
17	5.9	42	35.2	67	79.0	92	97.7
18	6.4	43	37.0	68	80.4	93	97.9
19	7.1	44	38.8	69	81.6	94	98.2
20	7.7	45	40.6	70	82.9	95	98.4
21	8.4	46	42.5	71	84.1	96	98.6
22	9.2	47	44.3	72	85.2	97	98.7
23	10.0	48	46.2	73	86.3	98	98.9
24	10.8	49	48.1	74	87.3	99	99.0
25	11.8	50	50.0	75	88.2		

Table B.2
Cumulative Normal Distribution

Z	Area	Z	Area	Z	Area
-3.25	.0006	1.00	.1587	1.15	.8749
-3.20	.0007	-0.95	.1711	1.20	.8849
-3.15	.0008	-0.90	.1841	1.25	.8944
-3.10	.0010	-0.85	.1977	1.30	.9032
-3.05	.0011	-0.80	.2119	1.35	.9115
-3.00	.0013	-0.75	.2266	1.40	.9192
-2.95	.0016	-0.70	.2420	1.45	.9265
-2.90	.0019	-0.65	.2578	1.50	.9332
-2.85	.0022	-0.60	.2743	1.55	.9394
-2.80	.0026	-0.55	.2912	1.60	.9452
-2.75	.0030	-0.50	.3085	1.65	.9505
-2.70	.0035	-0.45	.3264	1.70	.9554
-2.65	.0040	-0.40	.3446	1.75	.9599
-2.60	.0047	-0.35	.3632	1.80	.9641
-2.55	.0054	-0.30	.3821	1.85	.9678
-2.50	.0062	-0.25	.4013	1.90	.9713
-2.45	.0071	-0.20	.4207	1.95	.9744
-2.40	.0082	-0.15	.4404	2.00	.9772
-2.35	.0094	-0.10	.4602	2.05	.9798
-2.30	.0107	-0.05	.4801	2.10	.9821
-2.25	.0122			2.15	.9842
-2.20	.0139	0.00	.5000	2.20	.9861
-2.15	.0158			2.25	.9878
-2.10	.0179	0.05	.5199	2.30	.9893
-2.05	.0202	0.10	.5398	2.35	.9906
-2.00	.0228	0.15	.5596	2.40	.9918
-1.95	.0256	0.20	.5793	2.45	.9929
-1.90	.0287	0.25	.5987	2.50	.9938
-1.85	.0322	0.30	.6179	2.55	.9946
-1.80	.0359	0.35	.6378	2.60	.9953
-1.75	.0401	0.40	.6554	2.65	.9960
-1.70	.0446	0.45	.6736	2.70	.9965
-1.65	.0495	0.50	.6915	2.75	.9970
-1.60	.0548	0.55	.7088	2.80	.9974
-1.55	.0606	0.60	.7257	2.85	.9978
-1.50	.0668	0.65	.7422	2.90	.9981
-1.45	.0735	0.70	.7580	2.95	.9984
-1.40	.0808	0.75	.7734	3.00	.9987
-1.35	.0885	0.80	.7881	3.05	.9989
-1.30	.0968	0.85	.8023	3.10	.9990
-1.25	.1056	0.90	.8159	3.15	.9992
-1.20	.1151	0.95	.8289	3.20	.9993
-1.15	.1251	1.00	.8413	3.25	.9994
-1.10	.1357	1.05	.8531		
-1.05	.1469	1.10	.8643		

Z-score is then substituted in the previous formula to yield the NCE:

$$NCE = (21.06)\ (-0.70) + 50 = 35.3$$

Percentile scores can also be ascertained when NCEs are known. One method is to convert the NCE back to a Z-score using this formula:

$$Z = \frac{NCE - 50}{21.06}$$

The percentile equivalent to the NCE and Z-score may then be found by using a table containing normal standardized values or Z-scores and the cumulative area under the curve represented by each of these values (see Table B.2). To illustrate the usage of the Z-score table, assume that it is desirable to convert two NCEs--23.7 and 67.8--to percentiles. First, convert the NCEs to Z-scores:

$$Z_1 = \frac{23.7 - 50}{21.06} \qquad Z_2 = \frac{67.8 - 50}{21.06}$$

$$= \frac{-26.3}{21.06} \qquad = \frac{17.8}{21.06}$$

$$= -1.25 \qquad = 0.85$$

Next, the area under the curve for each Z-score is read from Table B.2; this area is equal to a percentile expressed as a decimal fraction. The area for Z_1 is 0.1056; for Z_2 is 0.8023. This means that the NCE = 23.7 is equivalent to a percentile score of 10.56 percent; NCE = 67.8, to a percentile score of 80.23 percent. When greater precision is desired in the Z-score values, simply use a table with more precise values for Z.

Another way to determine the percentile score equivalent to an NCE is to use a conversion table for NCEs-to-percentiles such as Table B.3. More precise tables such as this are also available, with NCEs ranging from 1.0 to 99.0 in increments of one-tenth.*

*For both precise conversion tables listing NCEs and percentiles, see Chiang and Rosen, Appendices A and B.

Table B.3

Percentile to Normal Curve Equivalent Conversion Table

NCE	Percentile	NCE	Percentile	NCE	Percentile	NCE	Percentile
1	1.0	26	36.5	51	50.5	76	64.9
2	6.7	27	37.1	52	51.1	77	65.6
3	10.4	28	37.7	53	51.6	78	66.3
4	13.1	29	38.3	54	52.1	79	67.0
5	15.4	30	39.0	55	52.6	80	67.7
6	17.3	31	39.6	56	53.2	81	68.5
7	18.9	32	40.1	57	53.7	82	69.3
8	20.4	33	40.7	58	54.2	83	70.1
9	21.8	34	41.3	59	54.8	84	70.9
10	23.0	35	41.9	60	55.3	85	71.8
11	24.2	36	42.5	61	55.9	86	72.8
12	25.3	37	43.0	62	56.4	87	73.7
13	26.3	38	43.6	63	57.0	88	74.7
14	27.2	39	44.1	64	57.5	89	75.8
15	28.2	40	44.7	65	58.1	90	77.0
16	29.1	41	45.2	66	58.7	91	78.2
17	29.9	42	45.8	67	59.3	92	79.6
18	30.7	43	46.3	68	59.9	93	81.1
19	31.5	44	46.8	69	60.4	94	82.7
20	32.3	45	47.4	70	61.0	95	84.6
21	33.0	46	47.9	71	61.7	96	86.9
22	33.7	47	48.4	72	62.3	97	89.6
23	34.4	48	48.9	73	62.9	98	93.3
24	35.1	49	49.5	74	63.5	99	99.0
25	35.8	50	50.0	75	64.2		

As Chiang and Rosen point out, whatever common metric is utilized by researchers evaluating data from numerous projects, it must possess four qualities:

- **Interpretability.** It must be meaningful and easily grasped by all groups of information users.
- **Sensitivity.** It should discriminate even small differences in pre-post scores.
- **Commonality.** The mean, variance, and distribution must be standardized across all tests.
- **Equal interval.** Any consecutive scale units should be an equal distance apart at any point on the continuum of the scale.

The NCE does enjoy all four of these characteristics. It is more interpretable than stanines and Z-scores; more sensitive than percentiles and stanines; is comparable across all tests, unlike grade equivalent and raw scores; and has an equal interval scale, unlike raw scores, grade equivalents and percentiles.

In order to utilize NCEs appropriately, the researcher must never compare scores derived from tests which were normed on different populations. Fortunately, most widely used standardized achievement tests are normed on what may be called a "representative" sample of the national population. Hence, NCEs for these tests can probably be compared safely with little concern for the equivalence of the various norming samples. In fact, the Anchor Test Study (Loret, et.al., 1975) indicated that the normative samples from the national population used by major test publishers are similar.

When using tests normed on a national sample, the NCEs indicate achievement relative to the national norm. Similarly, when using tests normed on some local sample, NCEs actually describe differences in achievement as compared to the local median in terms of the local variance. However, "local" NCEs are not

comparable to "national" NCEs, since they represent scores on tests using different norming populations.

NCE gain scores can be estimated from locally normed scores (for example, criterion-referenced test scores) and then used to compare with NCEs derived from nationally normed scores. The NCE gain is calculated using this formula (Chiang and Rosen, p. 10):

$$NCE = 21.06 \quad \frac{\bar{Y} - \hat{\bar{Y}}}{S_{LOCAL}} * \frac{S_{NRT}}{\sigma_{NRT}}$$

where $\bar{Y}$ = mean posttest score for treatment group;

$\hat{\bar{Y}}$ = mean posttest score for no-treatment or control group;

σ_{NRT} = national population standard deviation on a norm-referenced test, given in the test publisher's technical manual;

S_{NRT} = sample group's standard deviation on the same norm referenced test; and

S_{LOCAL} = sample group's standard deviation on the locally normed test.

The basis for this equation requires the assumption that the ratio between the sample group variance and the national population variance on a norm-referenced test should be equivalent to the ratio between the sample group variance and the national population variance on a locally normed test. In addition, the correlation between the norm-referenced and the locally normed tests must be high, thereby indicating that they are measuring approximately the same thing. Current research (Roudabush, 1975) indicates that this procedure is at least reasonable.